Cardio-Thoracic Ratio Evaluation of Cardiac Silhouette Compared with the Vertebral Heart Scale in Cats

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Abstract

The aim of the study was to compare the VHS with CTR and to assess the discrimination potential of CTR between normal heart size and microcardia or cardiomegaly in cats. The study included 125 cats, 68 females and 57 males with age between 1 and 17 years. The patients were distributed in 3 groups based on VHS: Group A (n=31) cats with small cardiac size (microcardia), Group B (n=51) cats with normal cardiac size and Group C (n=43) cats with heart enlargement (cardiomegaly). There was a good correlation between VHS and CTR for the entire studied group ($r^2=0.516$, $p<0.01$). There was a statistically significant correlation between VHS and CTR in normal heart size and cardiomegaly groups ($r^2=0.383$; $p<0.01$), ($r^2=0.339$, $p<0.05$). There was a poor correlation between VHS and CTR in microcardia ($r^2=0.164$; $p=0.378$).

There was statistically difference between microcardia group and normal cardiac size group ($p<0.05$) and also between cardiomegaly and normal cardiac size groups ($p<0.01$). Cardio-thoracic ratio is a valid method being well correlated with VHS. The CTR measurement can be used for assessing cardiac size in cats and can discriminate between normal heart size and microcardia or cardiomegaly.

Keywords: cat, cardiothoracic ratio, heart, vertebral heart scale, x-ray

INTRODUCTION

Thoracic radiography is an essential imaging method for assessing the cardiovascular and pulmonary modifications (Rudorf *et al.*, 2008). The heart is a muscular organ contrasting with the lung tissue surrounding it. (Johnson *et al.*, 2008)

Multiple methods have been developed in order to measure and quantify heart size in small animals and a variety of methods are being used. (Johnson *et al.*, 2008)

In 1995, Buchanan proposed a method for the cardiac size measurement in dogs, known as the vertebral heart scale (VHS) which is considered the most common and precise in veterinary medicine. It consists in scaling the dimensions of the long and short axis of the heart to the vertebral

bodies, starting from the cranial aspect of T4, towards the lumbar spinal column. The limits of the VHS for dogs were 9.7 ± 0.5 vertebrae without major differences between breeds. (Buchanan and Bucheler 1995)

Later, in 2000, Lister and Buchanan performed a study on 100 clinically normal cats. The limits of VHS were 7.5 ± 3 vertebrae. (Lister and Buchanan 2000)

Recently, a new planar method, the cardio-thoracic ratio (CTR), have been described, which measures the ratio between the heart and the thorax area. (Torad and Hassan 2014) From authors knowledge no study assessing the CTR value in cats have been described.

The aim of the study was to compare the VHS with CTR and to assess the discrimination potential of CTR between normal heart size and microcardia or cardiomegaly in cats.

MATERIALS AND METHODS

The study included 125 cats, from different breeds, 68 females and 57 males with age between 1 and 17 years, referred to the Roentgendiagnostic Laboratory of the Faculty of Veterinary Medicine in Iasi, for thoracic X-ray examination, between January 2013 and December 2014. The breeds investigated were European breed (n=88), Birmanese (n=88), Persian (n=55), Siamese (n=5), Angora (n=2), Russian Blue (n=1), Siberian (n=1) and Scottishfold (n=1).

Thoracic X-ray examination have been performed in left or right lateral recumbency for all the patients. The X-rays were performed with the Intermedical Basic 4006 X-ray machine, developing process was performed automatically with the HQ-350XT developer machine. The

parameters used for the exposure were between 44-47 Kv/1,3-1,6 mAs depending on the animal body condition. The X-ray film were 13/24 cm and 24/30 cm. Finally X-rays were scanned with the HP Scanjet G4050 scanner and transferred on a computer for measurement of the VHS and CTR.

The measurements were performed with Digimizer® software and included the VHS, the cardiac area (CA), the thoracic area (TA) and the CTR using the formula $(AC \times 100 / AC)$. The thoracic area (TA) and the cardiac area (AC) were assessed in pixels.

For the measurement of the thoracic area a line have been manually drawn from the point of the right crura of the lumbodiaphragmatic recess following the diaphragm cupola to the sterno-diaphragmatic angle, then the dorsal aspect of the sternum, until the cranial edge of the first sternebra, the thoracic inlet, the ventral border of the thoracic vertebral bodies and back to the right crura of the lumbodiaphragmatic recess. For the

Fig. 1. Lateral thoracic radiography of a cat showing the measurement method of VHS and CTR .

Tab. 1. The mean and standard deviation of VHS and CTR for the three groups of cats

Groups	Group A (microcardia)	Group B (normal heart size)	Group C (cardiomegaly)
Number of cats	31	51	43
Mean±SD VHS	6,92±0,22	7,47±0,19	8,35±0.50
Mean±SD CTR	18,48±1,94	19,79±2,41	21,75±3,42

cardiac area an outline have been traced to assess the cardiac silhouette (Fig.1).

The patients were distributed into 3 groups based on VHS value: Group A - microcardia (n=31), cats with small cardiac size, Group B (n=51) cats with normal cardiac size and Group C - cardiomegaly (n=43), cats with heart enlargement. The table below represents the mean and standard deviation for each group regarding the VHS and CTR values (Tab. 1).

RESULTS AND DISCUSSIONS

Authors found a good, linear, positive correlation ($r^2=0.516$, $p<0.01$) between the two methods, VHS and CTR for the entire studied group (Graphic 1).

There was also a statistically significant correlation between VHS and CTR in normal heart size ($r^2=0.383$; $p<0.01$) and cardiomegaly groups ($r^2=0.339$, $p<0.05$). Between VHS and CTR

in microcardia group no correlation was obtained ($r^2=0.164$; $p=0.378$) (Tab. 2).

There was a statistically significant difference between microcardia group and normal cardiac size group ($p<0.05$) and also between cardiomegaly and normal cardiac size groups ($p<0.01$) using the CTR method (Tab 3).

Because VHS is considered the golden standard for cardiac silhouette measurement for dogs and cats on X-ray, the groups distribution was based on this method and the CTR was used to assess the cardiac size. Furthermore, using the VHS method as reference, the authors assessed the discrimination potential between groups using the CTR measurement. The thorax and the heart of the cats have a similar conformation and the size and shape varies lesser than dogs (Johnson *et al.*, 2008), reducing the bias of the measurement ratio. The cardiothoracic ratio is a new method using

Graphic 1 Scatterplot showing the correlation between vertebral heart scale and cardio thoracic ratio for the entire studied group.

Tab. 2. Correlation between VHS and CTR among groups distributed by cardiac size using the VHS method.

Groups	R^2	p
Microcardia	0.164	0.378
Normal cardiac size	0.383	$p<0.01$
Cardiomegaly	0.339	$p<0.05$

Tab. 3. Statistic difference groups based on CTR measurement

CTR	P
Microcardia – Normal cardiac size	$p<0.05$
Cardiomegaly- Normal cardiac size	$p<0.01$

planar measurement instead of linear ones, the latter excluding some areas from the heart such as left atrium dilatation.

For a better reliability of the method, it would have been recommended the use of more specific measurements, such as ultrasonographic examination for diagnosing certain pathologies such as atrial enlargement which is very common in cats with hypertrophic cardiomyopathy (Fox, 2003).

CONCLUSIONS

Cardio-thoracic ratio is a valid method being well correlated with VHS. The CTR measurement can be used for assessing cardiac size in cats and can discriminate between normal heart size and microcardia or cardiomegaly.

The CTR measuring methods can determine the difference between normal cardiac silhouette and the enlarged one, therefore having a role in the diagnosis of cardiac disease (eccentric myocardial

hypertrophy, atrial dilatation, or pericardial effusion).

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